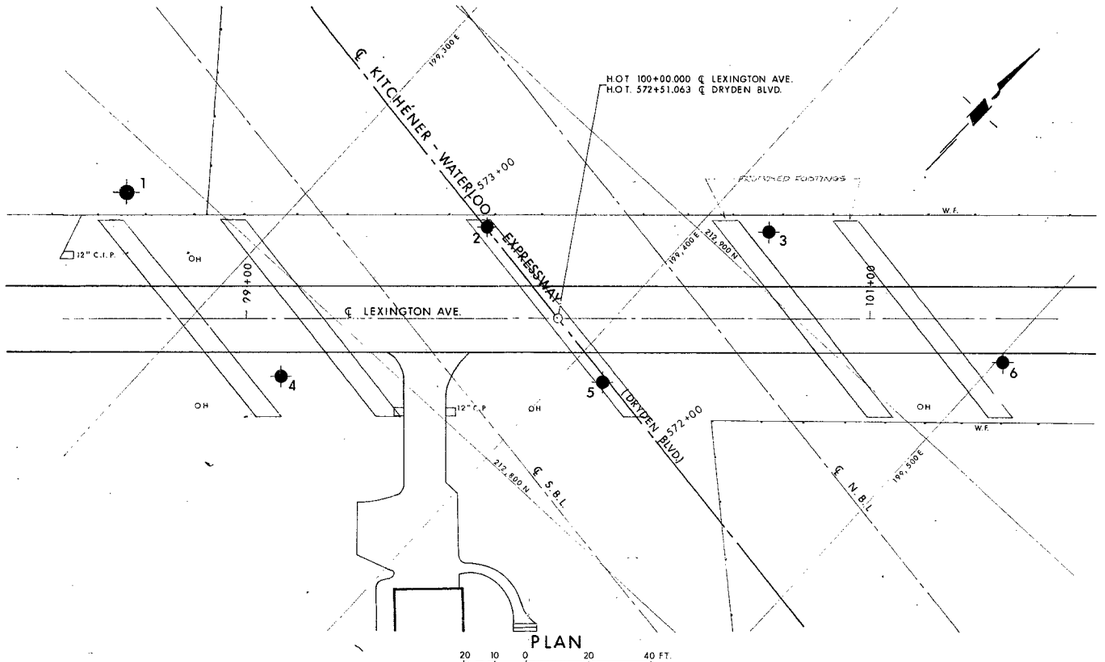
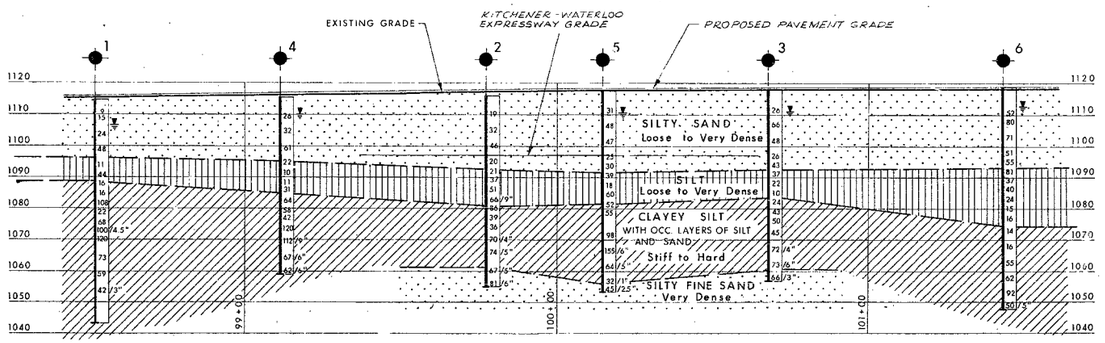
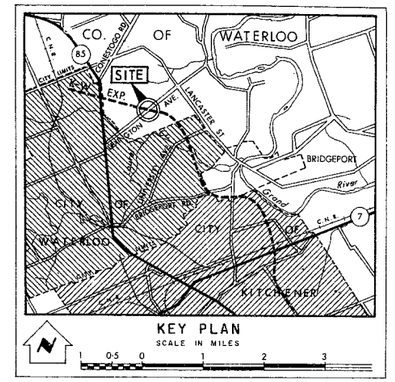
67-F-5
W.P. # 643-64
KITCHENER-
WATERLOO EXPRESSWAY
LEXINGTON
AVENUE





℄ PROFILE LEXINGTON AVE

20 10 0 20 40 FT.
SCALE



KEY PLAN
SCALE IN MILES
1 0.5 0 1 2 3

LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation. JAN, FEB 1967

NO.	ELEVATION	CO-ORDINATES NORTH	CO-ORDINATES EAST
1	1114.7	212,785.7	199,258.3
2	1116.1	212,855.0	199,350.2
3	1118.0	212,914.8	199,418.2
4	1115.3	212,774.8	199,334.8
5	1117.6	212,843.8	199,410.7
6	1118.9	212,935.2	199,504.4

— NOTE —

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

PRINT RECORD NO.	FOR	DATE

REVISIONS DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS – ONTARIO
MATERIALS & TESTING DIVISION – FOUNDATION SECTION

LEXINGTON AVENUE

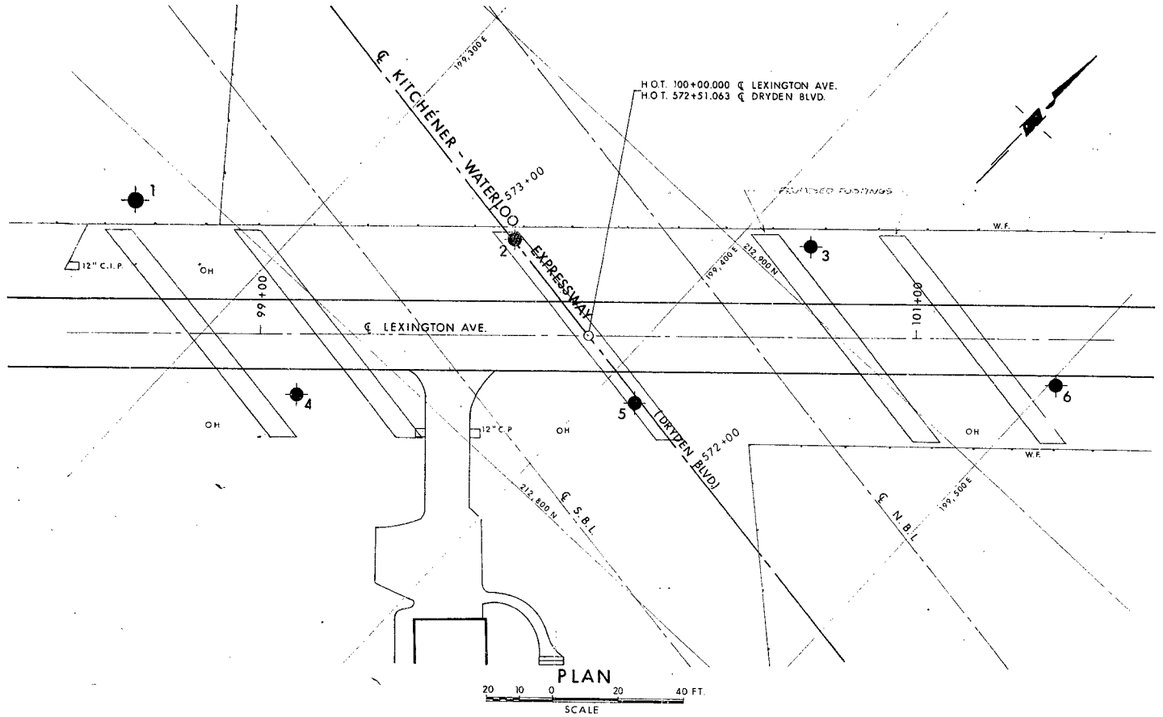
KING'S HIGHWAY NO. KITCHENER-WATERLOO EXPR. DIST. NO. 4
CO. WATERLOO CITY OF WATERLOO
TWP. LOT. CON.

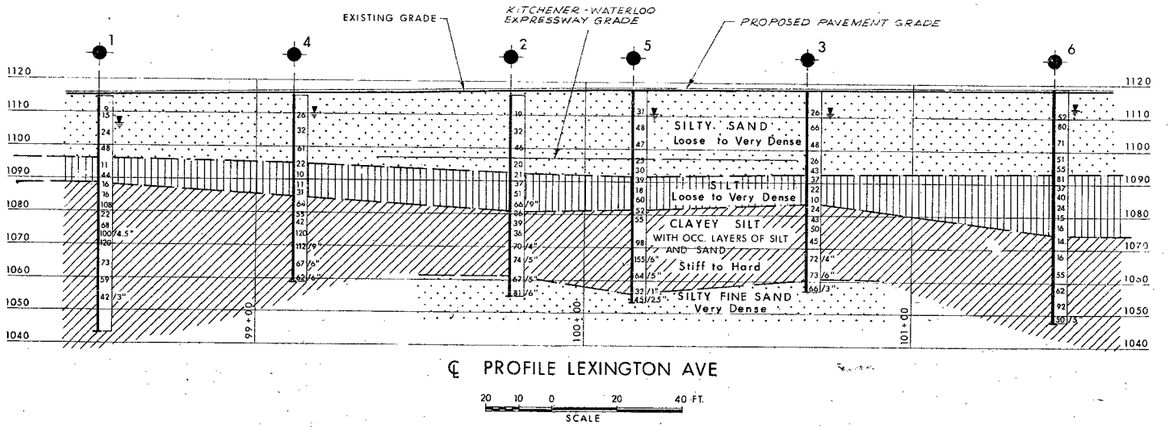
BORE HOLE LOCATIONS & SOIL STRATA

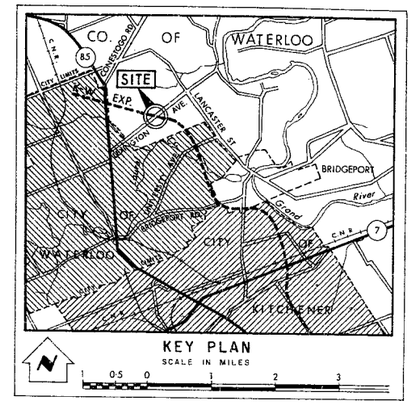
SUBM'D. P.P.	CHECKED A.R.	W.P. NO. 643-64	M.B.T. DRAWING NO. 67-F-5A
DRAWN J.D.D.	CHECKED A.R.	JOB NO. 67-F-5	
DATE 28 FEB. 1967	SITE NO		BRIDGE DRAWING NO. -
APPROVED A.R. Thomas PRINCIPAL FOUNDATION ENGINEER	CONT. NO. -		

REF. No 2147-SK-1 (MARGISON & ASSOC.)

67-F-5
W.P. # 643-64
KITCHENER-
WATERLOO EXPRESSWAY
LEXINGTON
AVENUE







LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation. JAN, FEB 1967

NO.	ELEVATION	CO-ORDINATES NORTH	CO-ORDINATES EAST
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3	1118.0	212,914.8	199,418.2
4	1115.3	212,774.8	199,334.8
5	1117.6	212,843.8	199,410.7
6	1118.9	212,935.2	199,504.4

– NOTE –

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

PRINT RECORD NO.	FOR	DATE

REVISIONS DATE	BY	DESCRIPTION

REF. No. 2147-SK-1 (MARGISON & ASSOC.)

DEPARTMENT OF HIGHWAYS – ONTARIO
MATERIALS & TESTING DIVISION – FOUNDATION SECTION

LEXINGTON AVENUE

KING'S HIGHWAY NO. KITCHENER-WATERLOO EXPR. DIST. NO. 4
CO. WATERLOO CITY OF WATERLOO
TWP. LOT. CON.

BORE HOLE LOCATIONS & SOIL STRATA

SUBM'D. P.P.	CHECKED A.R.	W.P. NO. 643-64	M.B.T. DRAWING NO. 67-F-5A
DRAWN J.D.D.	CHECKED A.R.	JOB NO. 67-F-5	
DATE 28 FEB. 1967		SITE NO	BRIDGE DRAWING NO. -
APPROVED A.G. Thomas PRINCIPAL FOUNDATION ENGINEER		CONT. NO. -	

cc : Gen. Files

DEPARTMENT OF HIGHWAYS ONTARIO

23-69-102

MEMORANDUM

To: Mr. B. R. Davis,
Bridge Engineer,
Bridge Division, Admin. Bldg.

Attention: Mr. S. McCombie

From: Foundation Section,
Materials & Testing Div.,
Room 107, Lab. Bldg.

Date: February 24, 1967

Our File Ref.

In reply to:

MAR 10 1967

Subject:

FOUNDATION INVESTIGATION REPORT
For
Proposed Lexington Ave. Underpass
Kitchener-Waterloo Expressway
District #4 (Hamilton)
W.J. 67-F-5 -- W.P. 643-64

Attached, we are forwarding to you, our detailed foundation investigation report on the subsoil conditions existing at the above structure site.

We believe that you will find the factual data and recommendations contained therein, adequate for your design requirements. Should you require additional information, please feel free to contact our Office.

A. G. Stermac
PRINCIPAL FOUNDATION ENGINEER

AGS/EdcF
Attach.

cc: Messrs. B. R. Davis (2)
H. A. Tregaskes
D. W. Farren
A. Cater
H. Greenland
W. S. Melinyshyn
J. Roy
W. D. Bradley
A. D. Margison
University of Waterloo

Foundations Files
Gen. Files

TABLE OF CONTENTS

FOUNDATION INVESTIGATION REPORT
For
Proposed Lexington Ave. Underpass
Kitchener-Waterloo Expressway
District #4 (Hamilton)
W.J. 67-F-5 -- W.P. 643-64

1. INTRODUCTION:

A request to carry out a foundation investigation for the proposed new underpass at Lexington Avenue and the Kitchener-Waterloo Expressway, was received from Mr. W. S. Melinyshyn, Regional Bridge Location Engineer, in a memo dated December 9, 1966.

An investigation was subsequently carried out by this Section to determine the subsoil conditions existing at the site of the proposed bridge.

This report contains the results of our field and laboratory investigations, together with our recommendations for the foundations of the new structure.

2. DESCRIPTION OF SITE:

The site is located about one mile east of the junction of Hwy. #85 and Lexington Ave. in the City of Waterloo. The immediate surrounding area is partly built up and the topography is flat to undulating.

Physiographically, this area is referred to as the 'Waterloo Hills'. The region is made up of sandy hills, some of them ridges of sandy till and others kames with outwash sand occupying the intervening hollows.

cont'd. /2 ...

3. FIELD AND LABORATORY WORK:

Six sampled boreholes were carried out during the course of the field work. Boring was achieved using a conventional diamond drill adapted for soil sampling purposes.

Samples were recovered using a 2-inch O.D. split-spoon sampler driven according to the specifications of the Standard Penetration Test. They were visually examined in the field and subsequently in the laboratory.

Laboratory tests were carried out on selected samples to determine Atterberg limits, grain-size distribution and natural moisture contents, where applicable.

The results of the laboratory and field tests are summarized in the Record of Borehole sheets which are contained in the appendix to this report.

The locations and elevations of the boreholes were determined by A. D. Margison and Associates Limited, and are given on Dwg. No. 67-F-5A, which is also contained in the report appendix.

4. SUBSOIL CONDITIONS:

4.1) General:

Subsoil at this site consists of stratified glacio-fluvial deposits of fine-grained composition. The surficial layer is silty sand, and ranges in thickness from 18.5 ft. to 26.0 ft. Its relative density is compact to very dense.

Underlying the silty sand is a layer of silt approximately 10 ft. thick. It has a relative density ranging from loose to very dense.

The next lower deposit consisted of hard clayey silt to silty clay with occasional layers of silt and sand. Below this was a very dense deposit of silty fine sand, which was only intersected in boreholes No's 2, 3 and 5.

From ground level downwards, the deposits are described as follows:

cont'd. /3 ...

4. SUBSOIL CONDITIONS: (cont'd.) ...

4.2) Silty Sand:

This deposit consists of a fine silty sand having a relative density which ranges from compact to very dense. The 'N' values (blows/foot in the Standard Penetration Test) ranged from 9 - 80 blows/foot.

Its thickness varies from 18.5 to 26.0 ft.

The average grain-size distribution was found to be: gravel 0%, sand 80%, silt and clay 20%.

Typical grain-size distribution curves are included in the report appendix.

4.3) Silt:

This deposit ranges in thickness from 9 - 18 feet. It can be considered to behave as a non-cohesive material of loose to very dense relative density.

The 'N' values ranged from 10 to 81 blows/foot.

4.4) Clayey Silt to Silty Clay with occasional Layers of Silt and Sand:

This deposit consisted of layers of clayey silt and silty clay of stiff to hard consistency, but generally hard.

The silty clay tended to be fissured with silt deposited along the sides of the fissures.

Layers of silt were also present and occasional thin layers of silty fine sand.

Reference should be made to the Record of Borehole sheets for details of the physical properties of this deposit.

cont'd. /4 ...

4. SUBSOIL CONDITIONS: (cont'd.) ...

4.5) Silty Fine Sand:

This deposit was found to be of very dense relative density, having 'N' values ranging from 67/5" to 45/2½".

5. GROUNDWATER CONDITIONS:

The groundwater levels shown on the Record of Borehole sheets were observed two weeks after completion of drilling during a mild spell of weather in which surface snow had melted. These groundwater levels are, therefore, considered to be purely seasonal. When the casing was pulled at the completion of boreholes No's 1 and 2, the uncased holes were observed to be caved and dry at some 15 feet below ground level.

6. DISCUSSION AND RECOMMENDATIONS:

It is proposed to construct an underpass structure at the crossing of Lexington Avenue and the Kitchener-Waterloo Expressway. Present proposals call for a four-span (38'-79'-79'-38') structure which spans a cutting some 22 feet below existing ground level.

The subsoil conditions existing at this site consist of 18.5 to 26.0 feet of loose to very dense silty fine sand which overlies approximately 10 feet of loose to dense silt and then hard clayey silt to silty clay.

The foundation conditions are such that spread footing foundations may be used for the bridge piers and abutments. The recommended footing elevations for the piers have been obtained using a depth of 4 ft. below the proposed final ground level to ensure adequate frost protection. The east end of each pier is, therefore, 2 feet lower than its west end. The footing may therefore be stepped or sloped uniformly between each end as required. The abutment foundation levels have been obtained assuming that

cont'd. /5 ...

6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

they will be founded approximately 10 feet below existing ground level. Detailed recommendations are made as follows:

The piers and abutments may be supported on spread footings founded at or below the following elevations:

	North Abutment	:	El. 1,104
West end,	North Pier	:	El. 1,093
" " ,	Centre Pier	:	El. 1,091
" " ,	South Pier	:	El. 1,095
	South Abutment	:	El. 1,106

A safe bearing pressure of 2.5 tons/ft.^{2} may be used for design purposes.

As excavations are required below groundwater level in material which is highly susceptible to boiling, a dewatering scheme is essential.

Boiling may be prevented by driving steel sheet piling to a depth below the bottom of the excavation equal to the hydraulic head above it, or by driving the sheeting 2 feet into the clayey silt to silty clay deposit. If these recommendations are carried out, only small differential settlements are anticipated.

No stability problems are anticipated for the construction of the cutting, provided standard 2:1 side slopes are adopted.

It is anticipated that the natural groundwater level will be depressed as the cutting is excavated. Should seepage take place from the sides of the excavation, steps will need to be taken to prevent it occurring. Adequate drainage possibly coupled with the use of graded filters on the side slopes, would be required to prevent sloughing. This should be determined at the time of construction.

cont'd. /6 ...

7. SUMMARY:

A foundation investigation at the site of the Lexington Avenue and Kitchener-Waterloo Expressway crossing is reported.

Subsoil at the site consists of loose to very dense silty fine sand overlying loose to dense silt, and then hard clayey silt to silty clay.

It is recommended that the piers and abutments of the proposed structure be supported on spread footings. Only small differential settlements are expected. Procedures for construction and dewatering have been outlined in this report.

No stability problems are anticipated for the construction of the cutting slopes, provided any seepage from the side slopes is prevented.

8. MISCELLANEOUS:

The field work for this project was carried out during the period January 25 - February 2, 1967, under the supervision of Mr. P. Payer, Project Foundation Engineer.

Equipment used was owned and operated by Canadian Longyear Limited.

This report was prepared by Mr. A. C. Calder, Project Foundation Engineer, and reviewed by Mr. K. G. Selby, Supervising Foundation Engineer.

February 1967.

APPENDIX I.

FORM DB-MT-126
66-4846

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 67-F-5 LOCATION 212,785.7N, 199,258.3E ORIGINATED BY PP
W.P. 643-64 BORING DATE 25 & 26 January 1967 COMPILED BY ACC
DATUM Geodetic BOREHOLE TYPE Washboring, NX Casing CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT / SHEAR STRENGTH P.S.F.	LIQUID LIMIT W_L / PLASTIC LIMIT W_P / WATER CONTENT W — WATER CONTENT % 25 50 75	BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT					
1114.7	GROUND LEVEL									
0.0	Silty sand Loose to dense		1	SS	9	1110				W.L. 1106.5
			2	SS	15					
			3	SS	24					
						1100				
			4	SS	48					
1096.2										
18.5	Silt Loose to Dense		5	SS	11					
			6	SS	44	1090		N.P.		
1088.7										
26.0	Clayey silt with occasional layers of silt and silty clay. Stiff to hard.		7	SS	16					
			8	SS	16					
			9	SS	108					
						1080				
			10	SS	22					
			11	SS	68					
			12	SS	100/4.5"					
						1070				
			13	SS	120					
			14	SS	73					
						1060				
			15	SS	59					
			16	SS	42/3"					
						1050				
1043.2			17	SS						
71.5	End of borehole					1040				

FORM OB-MT-126
66-4546

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

JOB 67-F-5 LOCATION 212,855.0N, 199,350.2E ORIGINATED BY PP
W.P. 643-64 BORING DATE January 26 - 30, 1967 COMPILED BY ACC
DATUM Geodetic BOREHOLE TYPE Washboring, CX Casi. CHECKED BY

SOIL PROFILE ELEV./DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT / SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w — WATER CONTENT % 25 50 75	BULK DENSITY γ P.C.F.	REMARKS
1116.1	GROUND LEVEL									
0.0	Silty sand									
	Compact to dense.		1	SS	19	1110				
			2	SS	32			o		
			3	SS	46	1100				
			4	SS	20			o		El. 1097.1 Hole caved and dry.
1093.1			5	SS	21			o N.P.		
23.0	Silt		6	SS	37	1090				
	Compact to very dense		7	SS	51			o N.P.		
			8	SS	66/9"			o		
1081.1			9	SS	86	1080		o		
35.0	Clayey silt to silty clay with occ. layers of silt and sand.		10	SS	39			o		
			11	SS	36			o		
			12	SS	70/4"	1070		o		
			13	SS	74/5"			o		
1061.1	Hard									
55.0	Silty Fine Sand.		14	SS	67/5"	1060				
	Very dense.		15	SS	81/6"			o		
1054.6										
61.5	End of Borehole					1050				

FORM OB-MT-126
66-4846

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

JOB 67-F-5 LOCATION 212,914.8N, 199,418.2E ORIGINATED BY PP
W.P. 613-64 BORING DATE January 31, 1967 COMPILED BY ACC
DATUM Geodetic BOREHOLE TYPE Washboring, BX Casing CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	REMARKS
1118.0	GROUND LEVEL						
0.0	Silty sand						
	Compact to very dense.		1	SS	26		WL. 1111.0
			2	SS	66		
			3	SS	48		
			4	SS	26		
1092.0			5	SS	43		
26.0	Silt		6	SS	37		
	Loose to dense		7	SS	22		
1083.0			8	SS	10		
35.0	Clayey silt to silty clay with occ. seams of silt. Very stiff to hard		9	SS	24		
			10	SS	43		
			11	SS	50		
			12	SS	45		
			13	SS	72/1"		
			14	SS	73/6"		
1060.0							
58.0	Silty fine sand. Very dense		15	SS	66/3"		
1056.5							
61.5	End of Borehole						

ELEV. SCALE: 1110, 1100, 1090, 1080, 1070, 1060, 1050

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT
SHEAR STRENGTH P.S.F.

LIQUID LIMIT — w_L
PLASTIC LIMIT — w_P
WATER CONTENT — w
w_P w w_L
WATER CONTENT % 25 50 75

BULK DENSITY P.C.F.

FORM DB-MT-126
66-4846

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 4

FOUNDATION SECTION

JOB 67-F-5 LOCATION 212,774.8N, 199,334.8E ORIGINATED BY PP
W.P. 643-64 BORING DATE January 31, 1967 COMPILED BY ACC
DATUM Geodetic BOREHOLE TYPE Washboring, BX Casing CHECKED BY

ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE
1115.3	GROUND LEVEL					
0.0	Silty sand					
	Compact to very dense		1	SS	26	1110
			2	SS	32	
			3	SS	61	1100
1095.3						
20.0	Silt		4	SS	22	
			5	SS	10	
	Loose to compact		6	SS	11	1090
1085.2			7	SS	31	
30.1	Clayey Silt to silty clay with occ. seams of silt.		8	SS	64	
			9	SS	58	1080
			10	SS	42	
			11	SS	120	
	Hard		12	SS	112/9"	1070
			13	SS	67/6"	
1058.8			14	SS	62/6"	1060
56.5	End of Borehole					1050

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT

SHEAR STRENGTH P.S.F.

LIQUID LIMIT — w_L
PLASTIC LIMIT — w_P
WATER CONTENT — w
w_P w w_L
WATER CONTENT %
25 50 75

BULK DENSITY
γ
P.C.F.

REMARKS

▼WL. 1110.1

FORM DB-MT-126
66-4846

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 5

FOUNDATION SECTION

JOB 67-F-5 LOCATION 212,843.8N, 199,410.7E ORIGINATED BY PP
W.P. 643-64 BORING DATE February 2, 1967 COMPILED BY ACC
DATUM Geodetic BOREHOLE TYPE Washboring, BX Casing CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE
1117.6	GROUND LEVEL					
0.0	Silty sand					
	Dense to compact.		1	SS	31	1110
			2	SS	48	
			3	SS	47	1100
			4	SS	25	
1091.6			5	SS	30	
26.0	Silt		6	SS	39	1090
	Compact to very dense		7	SS	18	
			8	SS	60	
1082.6			9	SS	52	1080
35.0	Clayey Silt to silty clay with occ. layers of silt and sand.		10	SS	55	
			11	SS		
			12	SS	98	1070
	Hard		13	SS	155/6"	
			14	SS	64/5"	1060
1056.1			15	SS	32/1"	
61.5	Silty fine sand.		16	SS	45/2.5"	
1053.1	Very dense					1050
64.5	End of borehole					

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT
SHEAR STRENGTH P.S.F.

LIQUID LIMIT w_L
PLASTIC LIMIT w_P
WATER CONTENT w
w_P w w_L
WATER CONTENT % 25 50 75

BULK DENSITY P.C.F.

REMARKS

▼1110.4

FORM OB-MT-126
66-4546

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 6

FOUNDATION SECTION

JOB 67-F-5 LOCATION 212,935.2N, 199,504.4E ORIGINATED BY PP
W.P. 643-64 BORING DATE February 1, 1967 COMPILED BY ACC
DATUM Geodetic BOREHOLE TYPE Washboring, BX Casing CHECKED BY MR.

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE
1118.9	GROUND LEVEL					
0.0	Silty sand					
	Very dense		1	SS	52	1110
			2	SS	80	
			3	SS	71	1100
			4	SS	51	
1092.9			5	SS	55	
26.0	Silt with occ. layers of clayey silt.		6	SS	81	1090
	Loose to very dense		7	SS	37	
			8	SS	40	
			9	SS	24	1080
			10	SS	15	
1074.9			11	SS	16	
44.0	Clayey silt to silty clay with occ. layers of silt.		12	SS	14	1070
			13	SS	16	
	Stiff to hard.		14	SS	55	
			15	SS	62	1060
			16	SS	92	
1047.4			17	SS	50/5"	1050
71.5	End of borehole					

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT
SHEAR STRENGTH P.S.F.

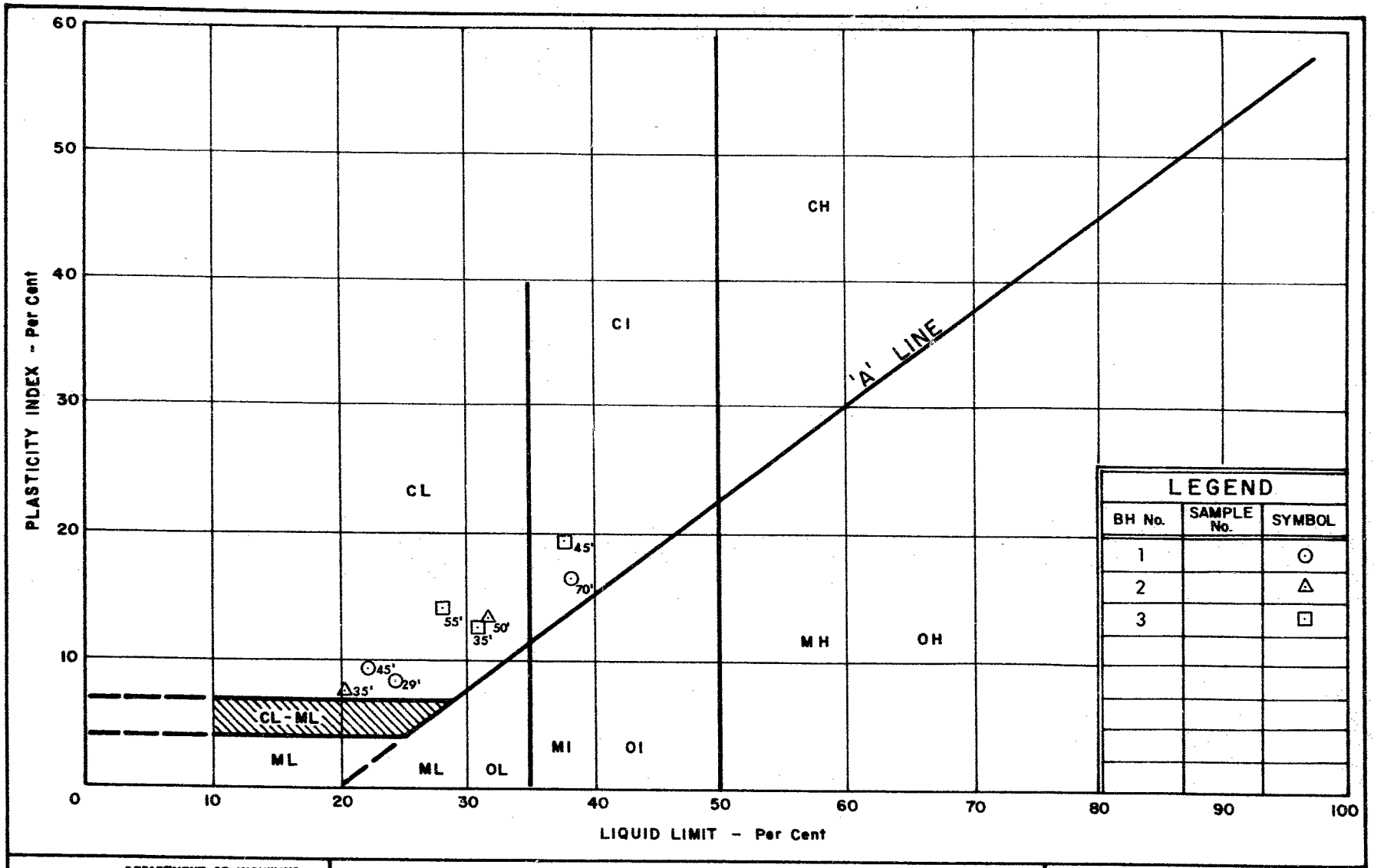
LIQUID LIMIT — w_L
PLASTIC LIMIT — w_P
WATER CONTENT — w
w_P w w_L
WATER CONTENT % 25 50 75

BULK DENSITY P.C.F.

REMARKS

WL. 1112.5

FORM CD-MT-252
(REV. JUNE 1965)
65-1624



DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION
ONTARIO

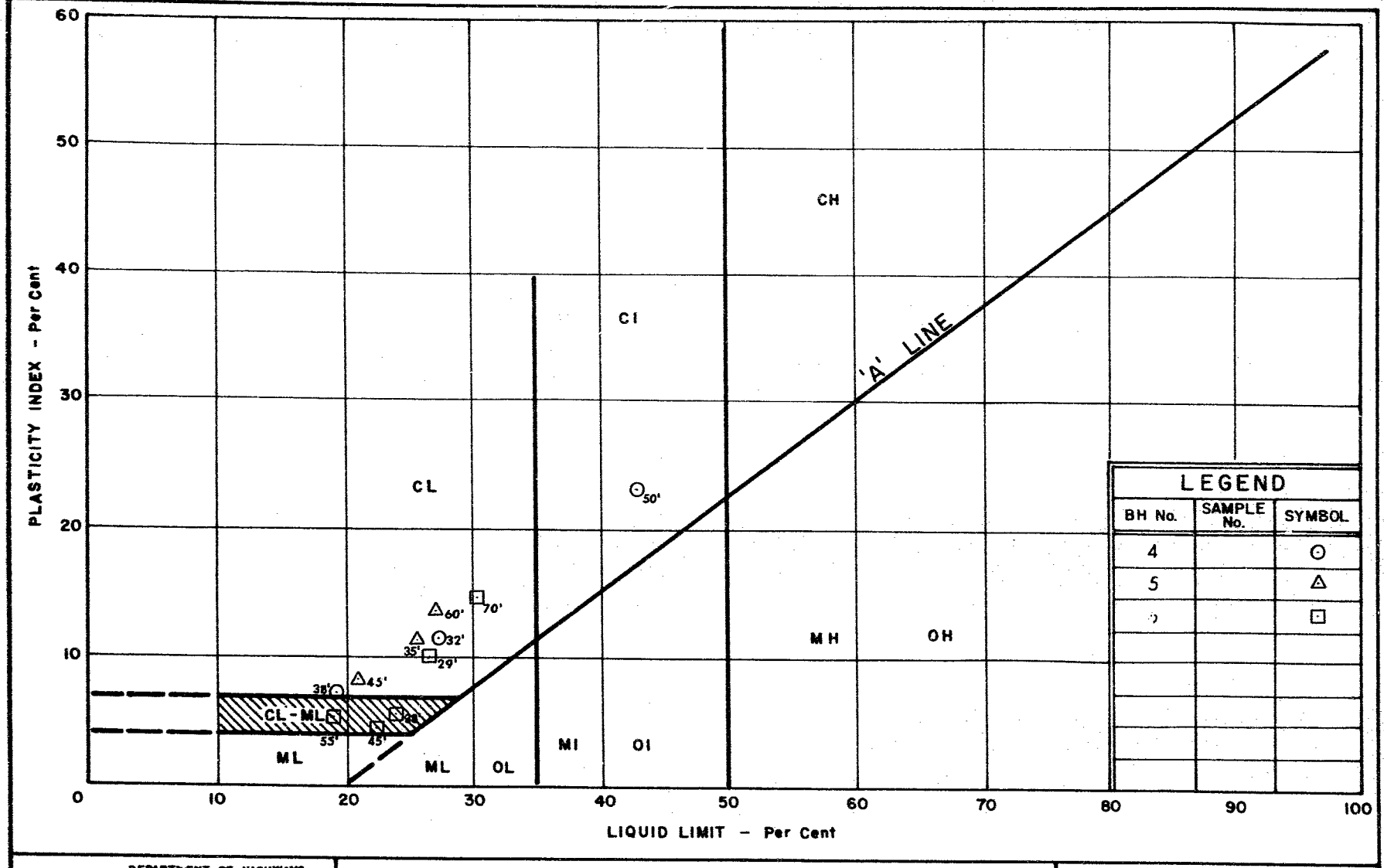
PLASTICITY CHART

CLAYEY SILT TO SILTY CLAY With Occasional Layers of Silt and Sand

W.P. No. 643-64

JOB No. 67-F-5

FORM GB-MT-252
(REV. JUNE 1965)
65-1624



DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION
ONTARIO

PLASTICITY CHART

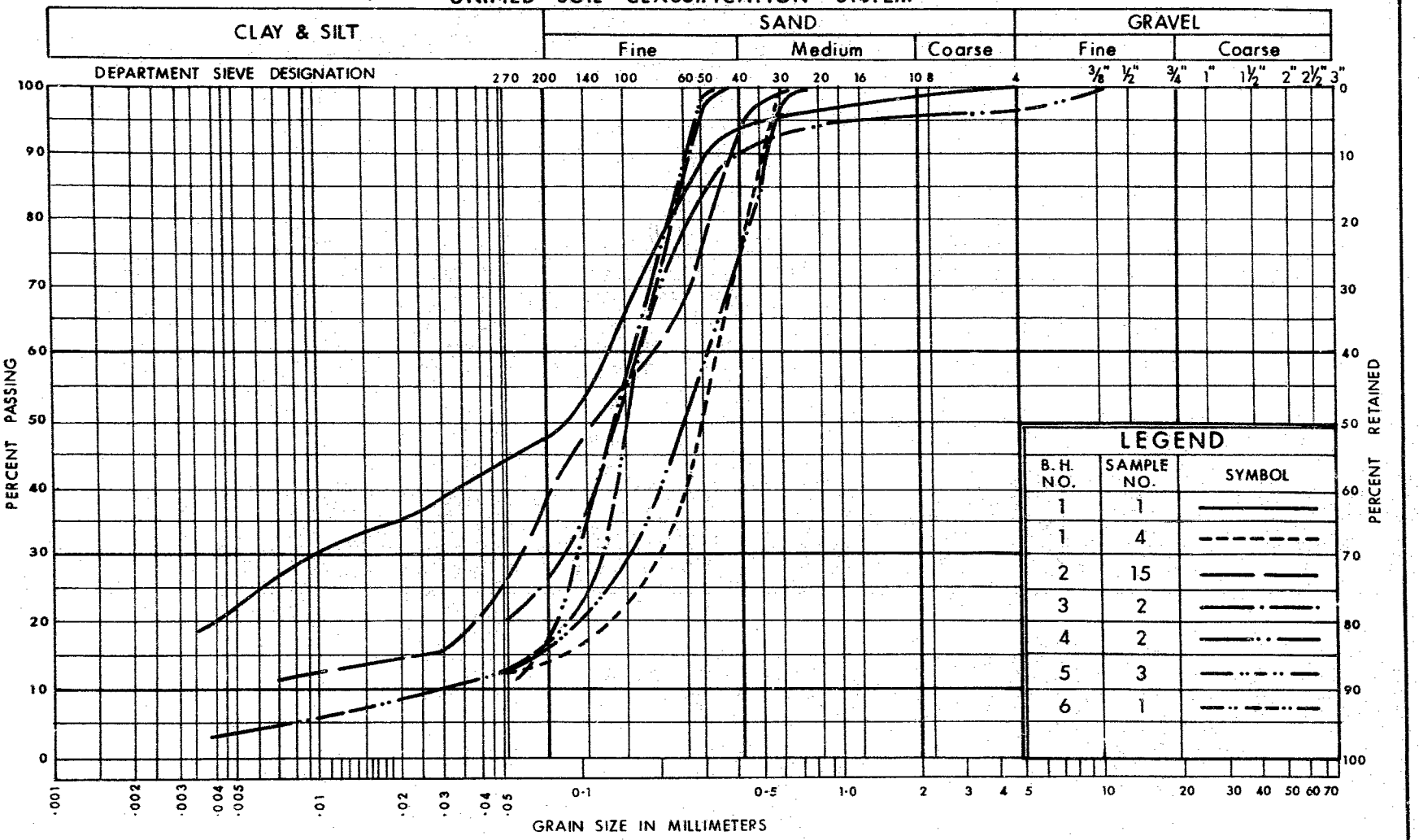
CLAYEY SILT TO SILTY CLAY With Occasional Layers of Silt and Sand

W.P. No. 643-64

JOB No. 67-F-5

FORM OB MT - 17
REV. APR. 1965
65-414

UNIFIED SOIL CLASSIFICATION SYSTEM



DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION
ONTARIO

GRAIN SIZE DISTRIBUTION
SILTY SAND

W.P. No. 643-64
JOB No. 67-F-5

ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' :- THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE :- THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS :-

CONSISTENCY	'N' BLOWS / FT.	c LB. / SQ. FT.	DENSENESS	'N' BLOWS / FT.
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		

TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE
S.T.	SLOTTED TUBE SAMPLE		
	P.H. SAMPLE ADVANCED HYDRAULICALLY		
	P.M. SAMPLE ADVANCED MANUALLY		

SOIL TESTS

Qu	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V	FIELD VANE
Qcu	CONSOLIDATED UNDRAIN. TRIAXIAL	C	CONSOLIDATION
Qd	DRAINED TRIAXIAL	S	SENSITIVITY

ABBREVIATIONS USED IN THIS REPORT

SOIL PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_P	PLASTIC LIMIT
I_P	PLASTICITY INDEX
s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX $= \frac{w - w_P}{I_P}$
I_C	CONSISTENCY INDEX $= \frac{w_L - w}{I_P}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX $= \frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE $= \frac{-\Delta e}{(1+e)\Delta \sigma'}$
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX $= \frac{\Delta e}{\Delta \log_{10} \sigma'}$
T_v	TIME FACTOR $= \frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION INTERCEPT — IN TERMS OF EFFECTIVE STRESS $\tau_f = c' + \sigma' \tan \phi'$
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION — IN TERMS OF EFFECTIVE STRESS $\tau_f = c' + \sigma' \tan \phi'$
c_u	APPARENT COHESION — IN TERMS OF TOTAL STRESS $\tau_f = c_u + \sigma \tan \phi$
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION — IN TERMS OF TOTAL STRESS $\tau_f = c_u + \sigma \tan \phi$
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

π	= 3·1416
e	BASE OF NATURAL LOGARITHMS 2·7183
$\log_e a$ OR $\ln a$	NATURAL LOGARITHM OF a
$\log_{10} a$ OR $\log a$	LOGARITHM OF a TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
σ'	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ε	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNGS MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_o	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY. DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL